

# Package ‘asa’

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**Title** AI Search Agent for Large-Scale Research Automation

**Version** 0.1.0

**Description** Provides an LLM-powered research agent for performing AI search tasks at large scales. Uses a ReAct (Reasoning + Acting) agent pattern with web search capabilities via DuckDuckGo and Wikipedia. Implements DeepAgent-style memory folding for context management. The agent is built on 'LangGraph' and supports multiple LLM backends including 'OpenAI', 'Groq', and 'xAI'.

**URL** <https://github.com/cjerzak/asa-software>

**BugReports** <https://github.com/cjerzak/asa-software/issues>

**Depends** R (>= 4.0.0)

**License** GPL-3

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**Imports** reticulate (>= 1.28),  
jsonlite,  
rlang

**Suggests** testthat (>= 3.0.0),  
knitr,  
rmarkdown,  
future,  
future.apply

**VignetteBuilder** knitr

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**Config/testthat/edition** 3

**SystemRequirements** Python (>= 3.11), Conda, Tor (optional, for anonymous searching)

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---

as.data.frame.asa_result
<i>Convert asa_result to Data Frame</i>

---

**Description**

Convert asa\_result to Data Frame

**Usage**

```
## S3 method for class 'asa_result'  
as.data.frame(x, ...)
```

**Arguments**

- x                    An asa\_result object
- ...                  Additional arguments (ignored)

**Value**

A single-row data frame

---

asa_agent	<i>Constructor for asa_agent Objects</i>
-----------	------------------------------------------

---

**Description**

Creates an S3 object representing an initialized ASA search agent.

**Usage**

```
asa_agent(python_agent, backend, model, config)
```

**Arguments**

python_agent	The underlying Python agent object
backend	LLM backend name (e.g., "openai", "groq")
model	Model identifier
config	Agent configuration list

**Value**

An object of class asa\_agent

---

asa_response	<i>Constructor for asa_response Objects</i>
--------------	---------------------------------------------

---

**Description**

Creates an S3 object representing an agent response.

**Usage**

```
asa_response(
    message,
    status_code,
    raw_response,
    trace,
    elapsed_time,
    fold_count,
    prompt
)
```

**Arguments**

message	The final response text
status_code	Status code (200 = success, 100 = error)
raw_response	The full Python response object
trace	Full text trace of agent execution
elapsed_time	Execution time in minutes
fold_count	Number of memory folds performed
prompt	The original prompt

**Value**

An object of class `asa_response`

---

<code>asa_result</code>	<i>Constructor for <code>asa_result</code> Objects</i>
-------------------------	--------------------------------------------------------

---

**Description**

Creates an S3 object representing the result of a research task.

**Usage**

```
asa_result(prompt, message, parsed, raw_output, elapsed_time, status)
```

**Arguments**

<code>prompt</code>	The original prompt
<code>message</code>	The agent's response text
<code>parsed</code>	Parsed output (list or NULL)
<code>raw_output</code>	Full agent trace
<code>elapsed_time</code>	Execution time in minutes
<code>status</code>	Status ("success" or "error")

**Value**

An object of class `asa_result`

---

<code>build_backend</code>	<i>Build the Python Backend Environment</i>
----------------------------	---------------------------------------------

---

**Description**

Creates a conda environment with all required Python dependencies for the asa search agent, including LangChain, LangGraph, and search tools.

**Usage**

```
build_backend(conda_env = "asa_env", conda = "auto", python_version = "3.13")
```

**Arguments**

<code>conda_env</code>	Name of the conda environment (default: "asa_env")
<code>conda</code>	Path to conda executable (default: "auto")
<code>python_version</code>	Python version to use (default: "3.13")

## Details

This function creates a new conda environment and installs the following Python packages:

- langchain\_groq, langchain\_community, langchain\_openai
- langgraph
- ddgs (DuckDuckGo search)
- selenium, primp (browser automation)
- beautifulsoup4, requests
- fake\_headers, httpx
- pysocks, socksio (proxy support)

## Value

Invisibly returns NULL; called for side effects.

## Examples

```
## Not run:  
# Create the default environment  
build_backend()  
  
# Create with a custom name  
build_backend(conda_env = "my_asa_env")  
  
## End(Not run)
```

---

build\_prompt

*Build a Task Prompt from Template*

---

## Description

Creates a formatted prompt by substituting variables into a template.

## Usage

```
build_prompt(template, ...)
```

## Arguments

template	A character string with placeholders in the form {variable_name}
...	Named arguments to substitute into the template

## Value

A formatted prompt string

## Examples

```
## Not run:
prompt <- build_prompt(
  template = "Find information about {{name}} in {{country}} during {{year}}",
  name = "Marie Curie",
  country = "France",
  year = 1903
)

## End(Not run)
```

---

check\_backend

*Check Python Environment Availability*

---

## Description

Checks if the required Python environment and packages are available.

## Usage

```
check_backend(conda_env = "asa_env")
```

## Arguments

conda\_env      Name of the conda environment to check

## Value

A list with components:

- available: Logical, TRUE if environment is ready
- conda\_env: Name of the environment checked
- python\_version: Python version if available
- missing\_packages: Character vector of missing packages (if any)

## Examples

```
## Not run:
status <- check_backend()
if (!status$available) {
  build_backend()
}

## End(Not run)
```

configure\_search

*Configure Python Search Parameters***Description**

Sets global configuration values for the Python search module. These values control timeouts, retry behavior, and result limits.

**Usage**

```
configure_search(
    max_results = NULL,
    timeout = NULL,
    max_retries = NULL,
    retry_delay = NULL,
    backoff_multiplier = NULL,
    captcha_backoff_base = NULL,
    page_load_wait = NULL,
    inter_search_delay = NULL,
    conda_env = "asa_env"
)
```

**Arguments**

max_results	Maximum number of search results to return (default: 10)
timeout	HTTP request timeout in seconds (default: 15)
max_retries	Maximum retry attempts on failure (default: 3)
retry_delay	Initial delay between retries in seconds (default: 2)
backoff_multiplier	Multiplier for exponential backoff (default: 1.5)
captcha_backoff_base	Base multiplier for CAPTCHA backoff (default: 3)
page_load_wait	Wait time after page load in seconds (default: 2)
inter_search_delay	Delay between consecutive searches in seconds (default: 0.5)
conda_env	Name of the conda environment (default: "asa_env")

**Value**

Invisibly returns a list with the current configuration

**Examples**

```
## Not run:
# Increase timeout for slow connections
configure_search(timeout = 30, max_retries = 5)

# Get more results
configure_search(max_results = 20)
```

```
# Add delay between searches to avoid rate limiting
configure_search(inter_search_delay = 2.0)

## End(Not run)
```

---

```
configure_search_logging
```

*Configure Python Search Logging Level*

---

## Description

Sets the logging level for the Python search module. This controls how much diagnostic output is produced during web searches.

## Usage

```
configure_search_logging(level = "WARNING", conda_env = "asa_env")
```

## Arguments

level	Log level: "DEBUG", "INFO", "WARNING" (default), "ERROR", or "CRITICAL"
conda_env	Name of the conda environment (default: "asa_env")

## Details

Log levels from most to least verbose:

- DEBUG: Detailed diagnostic information for debugging
- INFO: General operational information
- WARNING: Indicates something unexpected but not an error (default)
- ERROR: Serious problems that prevented an operation
- CRITICAL: Very serious errors

## Value

Invisibly returns the current logging level

## Examples

```
## Not run:
# Enable verbose debugging output
configure_search_logging("DEBUG")

# Run a search (will show detailed logs)
result <- run_task("What is the population of Tokyo?", agent = agent)

# Disable verbose output
configure_search_logging("WARNING")

## End(Not run)
```



---

**extract\_agent\_results** *Extract Structured Data from Agent Traces*

---

**Description**

Parses raw agent output to extract search snippets, Wikipedia content, URLs, JSON data, and search tier information. This is the main function for post-processing agent traces.

**Usage**

```
extract_agent_results(raw_output)
```

**Arguments**

raw_output	Raw output string from agent invocation (the trace field from an asa_response object)
------------	---------------------------------------------------------------------------------------

**Value**

A list with components:

- search\_snippets: Character vector of search result content
- search\_urls: Character vector of URLs from search results
- wikipedia\_snippets: Character vector of Wikipedia content
- json\_data: Extracted JSON data as a list (if present)
- search\_tiers: Character vector of unique search tiers used (e.g., "primp", "selenium", "ddgs", "requests")

**Examples**

```
## Not run:
response <- run_agent("Who is the president of France?", agent)
extracted <- extract_agent_results(response$trace)
print(extracted$search_snippets)
print(extracted$search_tiers) # Shows which search tier was used

## End(Not run)
```

---

**extract\_search\_snippets***Extract Search Snippets by Source Number*

---

**Description**

Extracts content from Search tool messages in the agent trace.

**Usage**

```
extract_search_snippets(text)
```

**Arguments**

text                      Raw agent trace text

**Value**

Character vector of search snippets, ordered by source number

**Examples**

```
## Not run:
snippets <- extract_search_snippets(response$trace)

## End(Not run)
```

---

extract\_search\_tiers    *Extract Search Tier Information*

---

**Description**

Extracts which search tier was used from the agent trace. The search module uses a multi-tier fallback system:

- primp: Fast HTTP client with browser impersonation (Tier 0)
- selenium: Headless browser for JS-rendered content (Tier 1)
- ddgs: Standard DDGS Python library (Tier 2)
- requests: Raw POST to DuckDuckGo HTML endpoint (Tier 3)

**Usage**

```
extract_search_tiers(text)
```

**Arguments**

text                      Raw agent trace text

**Value**

Character vector of unique tier names encountered (e.g., "primp", "selenium", "ddgs", "requests")

**Examples**

```
## Not run:
tiers <- extract_search_tiers(response$trace)
print(tiers) # e.g., "primp"

## End(Not run)
```

---

extract_urls	<i>Extract URLs by Source Number</i>
--------------	--------------------------------------

---

**Description**

Extracts URLs from Search tool messages in the agent trace.

**Usage**

```
extract_urls(text)
```

**Arguments**

text	Raw agent trace text
------	----------------------

**Value**

Character vector of URLs, ordered by source number

**Examples**

```
## Not run:  
urls <- extract_urls(response$trace)  
  
## End(Not run)
```

---

extract_wikipedia_content	<i>Extract Wikipedia Content</i>
---------------------------	----------------------------------

---

**Description**

Extracts content from Wikipedia tool messages in the agent trace.

**Usage**

```
extract_wikipedia_content(text)
```

**Arguments**

text	Raw agent trace text
------	----------------------

**Value**

Character vector of Wikipedia snippets

**Examples**

```
## Not run:
wiki <- extract_wikipedia_content(response$trace)

## End(Not run)
```

---

get\_agent

*Get the Current Agent*


---

**Description**

Returns the currently initialized agent, or NULL if not initialized.

**Usage**

```
get_agent()
```

**Value**

An asa\_agent object or NULL

**Examples**

```
## Not run:
agent <- get_agent()
if (is.null(agent)) {
  agent <- initialize_agent()
}

## End(Not run)
```

---

get\_tor\_ip

*Get External IP via Tor*


---

**Description**

Retrieves the external IP address as seen through Tor proxy.

**Usage**

```
get_tor_ip(proxy = "socks5h://127.0.0.1:9050")
```

**Arguments**

proxy                      Tor proxy URL

**Value**

IP address string or NA on failure

## Examples

```
## Not run:
ip <- get_tor_ip()
message("Current Tor IP: ", ip)

## End(Not run)
```

---

initialize_agent	<i>Initialize the ASA Search Agent</i>
------------------	----------------------------------------

---

## Description

Initializes the Python environment and creates the LangGraph agent with search tools (Wikipedia, DuckDuckGo). The agent can use multiple LLM backends and supports DeepAgent-style memory folding.

## Usage

```
initialize_agent(
  backend = "openai",
  model = "gpt-4.1-mini",
  conda_env = "asa_env",
  proxy = "socks5h://127.0.0.1:9050",
  use_memory_folding = TRUE,
  memory_threshold = 4L,
  memory_keep_recent = 2L,
  rate_limit = 0.2,
  timeout = 120L,
  verbose = TRUE
)
```

## Arguments

backend	LLM backend to use. One of: "openai", "groq", "xai", "exo", "openrouter"
model	Model identifier (e.g., "gpt-4.1-mini", "llama-3.3-70b-versatile")
conda_env	Name of the conda environment with Python dependencies
proxy	SOCKS5 proxy URL for Tor (default: "socks5h://127.0.0.1:9050"). Set to NULL to disable proxy.
use_memory_folding	Enable DeepAgent-style memory compression (default: TRUE)
memory_threshold	Number of messages before folding triggers (default: 4)
memory_keep_recent	Number of recent messages to preserve after folding (default: 2)
rate_limit	Requests per second for rate limiting (default: 0.2)
timeout	Request timeout in seconds (default: 120)
verbose	Print status messages (default: TRUE)

## Details

The agent is created with two tools:

- Wikipedia: For looking up encyclopedic information
- DuckDuckGo Search: For web searches with a 4-tier fallback system (PRIMP -> Selenium -> DDGS library -> raw requests)

Memory folding (enabled by default) compresses older messages into a summary to manage context length in long conversations, following the DeepAgent paper.

## Value

An object of class `asa_agent` containing the initialized agent and configuration.

## API Keys

The following environment variables should be set based on your backend:

- OpenAI: `OPENAI_API_KEY`
- Groq: `GROQ_API_KEY`
- xAI: `XAI_API_KEY`
- OpenRouter: `OPENROUTER_API_KEY`

## OpenRouter Models

When using the "openrouter" backend, model names must be in provider/model-name format. Examples:

- "openai/gpt-4o"
- "anthropic/claude-3-sonnet"
- "google/gemma-2-9b-it:free"
- "meta-llama/llama-3-70b-instruct"

See <https://openrouter.ai/models> for available models.

## See Also

[run\\_agent](#), [run\\_task](#)

## Examples

```
## Not run:
# Initialize with OpenAI
agent <- initialize_agent(
  backend = "openai",
  model = "gpt-4.1-mini"
)

# Initialize with Groq and custom settings
agent <- initialize_agent(
  backend = "groq",
  model = "llama-3.3-70b-versatile",
  use_memory_folding = FALSE,
  proxy = NULL # No Tor proxy
```

```

)

# Initialize with OpenRouter (access to 100+ models)
agent <- initialize_agent(
  backend = "openrouter",
  model = "anthropic/claude-3-sonnet" # Note: provider/model format
)

## End(Not run)

```

---

is_tor_running	<i>Check if Tor is Running</i>
----------------	--------------------------------

---

### Description

Checks if Tor is running and accessible on the default port.

### Usage

```
is_tor_running(port = 9050L)
```

### Arguments

port	Port number (default: 9050)
------	-----------------------------

### Value

Logical indicating if Tor appears to be running

### Examples

```

## Not run:
if (!is_tor_running()) {
  message("Start Tor with: brew services start tor")
}

## End(Not run)

```

---

print.asa_agent	<i>Print Method for asa_agent Objects</i>
-----------------	-------------------------------------------

---

### Description

Print Method for asa\_agent Objects

### Usage

```

## S3 method for class 'asa_agent'
print(x, ...)

```

**Arguments**

x	An asa_agent object
...	Additional arguments (ignored)

**Value**

Invisibly returns the object

---

print.asa_response	<i>Print Method for asa_response Objects</i>
--------------------	----------------------------------------------

---

**Description**

Print Method for asa\_response Objects

**Usage**

```
## S3 method for class 'asa_response'  
print(x, ...)
```

**Arguments**

x	An asa_response object
...	Additional arguments (ignored)

**Value**

Invisibly returns the object

---

print.asa_result	<i>Print Method for asa_result Objects</i>
------------------	--------------------------------------------

---

**Description**

Print Method for asa\_result Objects

**Usage**

```
## S3 method for class 'asa_result'  
print(x, ...)
```

**Arguments**

x	An asa_result object
...	Additional arguments (ignored)

**Value**

Invisibly returns the object



---

process_outputs	<i>Process Multiple Agent Outputs</i>
-----------------	---------------------------------------

---

**Description**

Processes a data frame of raw agent outputs, extracting structured data.

**Usage**

```
process_outputs(df, parallel = FALSE, workers = 10L)
```

**Arguments**

df	Data frame with a 'raw_output' column containing agent traces
parallel	Use parallel processing
workers	Number of workers

**Value**

The input data frame with additional extracted columns: search\_count, wiki\_count, and any JSON fields found

---

reset_agent	<i>Reset the Agent</i>
-------------	------------------------

---

**Description**

Clears the initialized agent state, forcing reinitialization on next use. Also closes any open HTTP clients to prevent resource leaks.

**Usage**

```
reset_agent()
```

**Value**

Invisibly returns NULL

---

rotate_tor_circuit	<i>Rotate Tor Circuit</i>
--------------------	---------------------------

---

**Description**

Requests a new Tor circuit by restarting the Tor service.

**Usage**

```
rotate_tor_circuit(method = c("brew", "systemctl", "signal"), wait = 12L)
```

**Arguments**

method	Method to restart: "brew" (macOS), "systemctl" (Linux), or "signal"
wait	Seconds to wait for new circuit (default: 12)

**Value**

Invisibly returns NULL

**Examples**

```
## Not run:
rotate_tor_circuit()

## End(Not run)
```

---

run_agent	<i>Run the ASA Agent with a Custom Prompt</i>
-----------	-----------------------------------------------

---

**Description**

Invokes the search agent with an arbitrary prompt, returning the full agent trace and response. This is the low-level function for running the agent; for structured task execution, use [run\\_task](#).

**Usage**

```
run_agent(prompt, agent = NULL, recursion_limit = NULL, verbose = FALSE)
```

**Arguments**

prompt	The prompt to send to the agent
agent	An asa_agent object from <a href="#">initialize_agent</a> , or NULL to use/create the default agent
recursion_limit	Maximum number of agent steps (default: 100 for memory folding, 20 otherwise)
verbose	Print status messages (default: FALSE)

**Value**

An object of class `asa_response` containing:

- `message`: The final response text
- `status_code`: 200 for success, 100 for error
- `raw_response`: The full Python response object
- `trace`: Full text trace of agent execution
- `elapsed_time`: Execution time in minutes
- `fold_count`: Number of memory folds (if memory folding enabled)

**See Also**

[initialize\\_agent](#), [run\\_task](#)

**Examples**

```
## Not run:
# Run with a custom prompt
agent <- initialize_agent()
result <- run_agent(
  prompt = "Who was the 44th president of the United States?",
  agent = agent
)
print(result$message)

## End(Not run)
```

---

run\_agent\_batch

*Run Agent in Batch Mode*


---

**Description**

Runs the agent on multiple prompts, optionally in parallel.

**Usage**

```
run_agent_batch(
  prompts,
  agent = NULL,
  parallel = FALSE,
  workers = 4L,
  progress = TRUE
)
```

**Arguments**

<code>prompts</code>	Character vector of prompts
<code>agent</code>	An <code>asa_agent</code> object
<code>parallel</code>	Use parallel processing (requires <code>future.apply</code> package)
<code>workers</code>	Number of parallel workers (default: 4)
<code>progress</code>	Show progress bar (default: TRUE)

**Value**

A list of `asa_response` objects

**Examples**

```
## Not run:
prompts <- c(
  "What is the population of Tokyo?",
  "What is the population of New York?"
)
results <- run_agent_batch(prompts, agent)

## End(Not run)
```

---

run_task	<i>Run a Structured Task with the Agent</i>
----------	---------------------------------------------

---

**Description**

Executes a research task using the AI search agent with a structured prompt and returns parsed results.

**Usage**

```
run_task(prompt, output_format = "text", agent = NULL, verbose = FALSE)
```

**Arguments**

prompt	The task prompt or question for the agent to research
output_format	Expected output format. One of: "text" (raw response), "json" (parse as JSON), or a character vector of field names to extract
agent	An <code>asa_agent</code> object from <a href="#">initialize_agent</a> , or NULL to use the currently initialized agent
verbose	Print progress messages (default: FALSE)

**Details**

This function provides a high-level interface for running research tasks. For simple text responses, use `output_format = "text"`. For structured outputs, use `output_format = "json"` or specify field names to extract.

**Value**

An object of class `asa_result` with components:

- `prompt`: The original prompt
- `message`: The agent's response text
- `parsed`: Parsed output (if `output_format` specified)
- `raw_output`: Full agent trace
- `elapsed_time`: Execution time in minutes
- `status`: "success" or "error"

**See Also**

[initialize\\_agent](#), [run\\_agent](#), [run\\_task\\_batch](#)

**Examples**

```
## Not run:
# Initialize agent first
agent <- initialize_agent(backend = "openai", model = "gpt-4.1-mini")

# Simple text query
result <- run_task(
  prompt = "What is the capital of France?",
  output_format = "text",
  agent = agent
)
print(result$message)

# JSON structured output
result <- run_task(
  prompt = "Find information about Albert Einstein and return JSON with
           fields: birth_year, death_year, nationality, field_of_study",
  output_format = "json",
  agent = agent
)
print(result$parsed)

## End(Not run)
```

---

run\_task\_batch

*Run Multiple Tasks in Batch*


---

**Description**

Executes multiple research tasks, optionally in parallel.

**Usage**

```
run_task_batch(
  prompts,
  output_format = "text",
  agent = NULL,
  parallel = FALSE,
  workers = 4L,
  progress = TRUE
)
```

**Arguments**

prompts	Character vector of task prompts, or a data frame with a 'prompt' column
output_format	Expected output format (applies to all tasks)
agent	An <code>asa_agent</code> object

parallel	Use parallel processing
workers	Number of parallel workers
progress	Show progress messages

**Value**

A list of `asa_result` objects, or if prompts was a data frame, the data frame with result columns added

**Examples**

```
## Not run:
prompts <- c(
  "What is the population of Tokyo?",
  "What is the population of New York?",
  "What is the population of London?"
)
results <- run_task_batch(prompts, agent = agent)

## End(Not run)
```

---

summary.asa_agent	<i>Summary Method for asa_agent Objects</i>
-------------------	---------------------------------------------

---

**Description**

Summary Method for `asa_agent` Objects

**Usage**

```
## S3 method for class 'asa_agent'
summary(object, ...)
```

**Arguments**

object	An <code>asa_agent</code> object
...	Additional arguments (ignored)

**Value**

Invisibly returns a summary list

---

summary.asa\_response     *Summary Method for asa\_response Objects*

---

**Description**

Summary Method for asa\_response Objects

**Usage**

```
## S3 method for class 'asa_response'  
summary(object, show_trace = FALSE, ...)
```

**Arguments**

object	An asa_response object
show_trace	Include full trace in output
...	Additional arguments (ignored)

**Value**

Invisibly returns a summary list

---

summary.asa\_result     *Summary Method for asa\_result Objects*

---

**Description**

Summary Method for asa\_result Objects

**Usage**

```
## S3 method for class 'asa_result'  
summary(object, ...)
```

**Arguments**

object	An asa_result object
...	Additional arguments (ignored)

**Value**

Invisibly returns a summary list

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